

WHAT IS CLAIMED IS:

1. A method for recovering and maintaining data consistency between volumes of first and second storage systems which are connected to each other via a path, the first storage system being connected to a host, the  
5 method comprising the steps of:

providing a primary volume to the first storage system and a remote secondary volume to the second storage system, the remote secondary volume being a copied volume of the primary volume, the primary volume and the remote secondary volume being in synchronous mode;

10 providing a local secondary volume in the first storage system, the local secondary volume having stored therein journal logs of write input/output (I/O) commands issued by the host to the primary volume to store write data in the primary volume and old data including write data of the write I/O commands; and

15 conducting recovery of data on the primary volume from the local secondary volume when necessary by performing recovery of data of the primary volume based on the old data and the journal logs while maintaining the primary volume and the remote secondary volume in the synchronous mode.

20 2. A method according to claim 1, wherein the journal logs are stored in a journal log table.

3. A method according to claim 2, wherein a journal function  
25 management table is provided to be accessible and used by said first storage

system to manage a process of taking journal logs as represented by said journal log table and a process of recovery of said primary volume to a certain point in time image based on the journal logs.

5           4.       A method according to claim 3, wherein when said journal function management table is used to manage a process of taking journal logs, said journal log table is referred to obtain information indicating a location where a journal log including said write I/O command and said write data are to be stored and a sequence number for use in identifying said journal log, and said journal log and sequence number are stored in said location indicated by said information.

             5.       A method according to claim 4, wherein when said journal function management table is used to manage a process of recovery of said primary volume to a certain point in time image based on the journal logs, said journal log table is referred to sequentially apply the journal logs to the old data according to sequence numbers stored with the journal logs with the result being stored in the primary volume, thereby recovering the primary volume to a certain point in time image.

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             6.       A method according to claim 1, wherein the recovery of data on the primary volume is performed by applying the journal logs to the old data and storing the result in the primary volume.

7. A method according to claim 6, wherein said recovery of the primary volume while maintaining the primary volume and the remote secondary volume in the synchronous mode is conducted by sending the result of applying the journal logs to the old data to the second storage system  
5 and storing the result in the remote secondary volume.

8. A method according to claim 1, wherein each of said first and second storage systems comprises:  
a storage device having a plurality of disk drives each for storing data;  
10 and  
a storage controller for controlling said storage device,  
wherein said storage controller comprises:  
a front end controller for interfacing with a channel of an external device,  
15 at least one back end controller for interfacing with said storage device  
a shared memory for temporarily storing data including control data transferred between said external device and said storage device, and  
an interconnection apparatus for interconnecting said front end controller, said at least one back end controller and said shared memory.

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9. A method according to claim 8, wherein said primary volume of said first storage system is a logical volume supported by said disk drives included in said storage device, and  
wherein said local secondary volume of said first storage system is a  
25 logical volume supported by said disk drives included in said storage device.

10. A method for recovering and maintaining data consistency between volumes of first and second storage systems which are connected to each other via a path, the first storage system being connected to a host, the method comprising the steps of:

5 providing a primary volume to the first storage system and a remote secondary volume to the second storage system, the remote secondary volume being a copied volume of the primary volume, the primary volume and the remote secondary volume being in synchronous mode;

providing a local secondary volume in the first storage system,

10 wherein the local secondary volume has stored therein journal logs of write input/output (I/O) commands issued by the host to the primary volume to store write data in the primary volume and a base volume including an image of the primary volume at a certain point in time,

wherein the remote secondary volume has stored therein journal logs  
15 of write input/output (I/O) commands issued by the host to the primary volume and sent to said second storage system to store write data in the remote secondary volume, a base volume including a copied image of the primary volume and a replica base volume including a copy of the base volume; and

conducting recovery of data on the primary volume from the local  
20 secondary volume when necessary by performing recovery of data of the primary volume based on the base volume and the journal logs included in the local secondary volume while maintaining the primary volume and the remote secondary volume in the synchronous mode.

11. A method according to claim 10, wherein the recovery of data on the primary volume is performed by applying the journal logs to the base volume and storing the result in the primary volume.

5 12. A method according to claim 11, wherein the recovery of data on the remote secondary volume is performed by applying the journal logs to the replica base volume, and storing the result in the base volume of the remote secondary volume.

10 13. A method according to claim 11, wherein storing the result of applying the journal logs to the base volume in the primary volume includes swapping the base volume for the primary volume.

15 14. A method according to claim 12, wherein storing the result of applying the journal logs to the replica base volume in the base volume of the remote secondary volume includes swapping the replica base volume for the base volume.

20 15. A storage system comprising:  
a first storage apparatus which is connected to a host and includes a primary volume; and  
a second storage apparatus which is connected to said first storage apparatus via a path and includes a remote secondary volume,

wherein the remote secondary volume is a copied volume of the primary volume and the primary volume and the remote secondary volume are in synchronous mode,

5 wherein said first storage apparatus further includes a local secondary volume, the local secondary volume having stored therein journal logs of write input/output (I/O) commands issued by the host to the primary volume to store write data in the primary volume and old data including write data of the write I/O commands, and

10 wherein recovery of data on the primary volume from the local secondary volume is conducted by performing recovery of data of the primary volume based on the old data and the journal logs while maintaining the primary volume and the remote secondary volume in the synchronous mode.

16. A storage system according to claim 15, wherein the journal  
15 logs are stored in a journal log table.

17. A storage system according to claim 16, wherein a journal  
function management table is provided to be accessible and used by said first  
storage system to manage a process of taking journal logs as represented by  
20 said journal log table and a process of recovery of said primary volume to a  
certain point in time image based on the journal logs.

18. A storage system according to claim 17, wherein when said  
journal function management table is used to manage a process of taking  
25 journal logs, said journal log table is referred to obtain information indicating a

location where a journal log including said write I/O command and said write data are to be stored and a sequence number for use in identifying said journal log, and said journal log and sequence number are stored in said location indicated by said information.

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19. A storage system according to claim 18, wherein when said journal function management table is used to manage a process of recovery of said primary volume to a certain point in time image based on the journal logs, said journal log table is referred to sequentially apply the journal logs to the old data according to sequence numbers stored with the journal logs with the result being stored in the primary volume, thereby recovering the primary volume to a certain point in time image.

20. A storage system according to claim 15, wherein the recovery of data on the primary volume is performed by applying the journal logs to the old data and storing the result in the primary volume.

21. A storage system according to claim 20, wherein said recovery of the primary volume while maintaining the primary volume and the remote secondary volume in the synchronous mode is conducted by sending the result of applying the journal logs to the old data to the second storage system and storing the result in the remote secondary volume.

22. A storage system according to claim 15, wherein each of said first and second storage systems comprises:

a storage device having a plurality of disk drives each for storing data;  
and

a storage controller for controlling said storage device,

wherein said storage controller comprises:

5 a front end controller for interfacing with a channel of an external  
device,

at least one back end controller for interfacing with said storage device

a shared memory for temporarily storing data including control data  
transferred between said external device and said storage device, and

10 an interconnection apparatus for interconnecting said front end  
controller, said at least one back end controller and said shared memory.

23. A storage system according to claim 22, wherein said primary  
volume of said first storage system is a logical volume supported by said disk  
15 drives included in said storage device, and

wherein said local secondary volume of said first storage system is a  
logical volume supported by said disk drives included in said storage device.

24. A storage system comprising:

a first storage apparatus which is connected to a host and includes a  
20 primary volume; and

a second storage apparatus which is connected to said first storage  
apparatus via a path and includes a remote secondary volume,

wherein the remote secondary volume is a copied volume of the  
primary volume and the primary volume and the remote secondary volume  
25 are in synchronous mode,



wherein said first storage apparatus further includes a local secondary volume, the local secondary volume having stored therein journal logs of write input/output (I/O) commands issued by the host to the primary volume to store write data in the primary volume and a base volume including an image of the primary volume at a certain point in time,

wherein the remote secondary volume has stored therein journal logs of write input/output (I/O) commands issued by the host to the primary volume and sent to said second storage system to store write data in the remote secondary volume, a base volume including a copied image of the primary volume and a replica base volume including a copy of the base volume, and

wherein recovery of data on the primary volume from the local secondary volume is conducted by performing recovery of data of the primary volume based on the base volume and the journal logs included in the local secondary volume while maintaining the primary volume and the remote secondary volume in the synchronous mode.

25. A storage system according to claim 24, wherein the recovery of data on the primary volume is performed by applying the journal logs to the base volume and storing the result in the primary volume.

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26. A storage system according to claim 25, wherein the recovery of data on the remote secondary volume is performed by applying the journal logs to the replica base volume, and storing the result in the base volume of the remote secondary volume.

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27. A storage system according to claim 25, wherein storing the result of applying the journal logs to the base volume in the primary volume includes swapping the base volume for the primary volume.

5            28. A storage system according to claim 26, wherein storing the result of applying the journal logs to the replica base volume in the base volume of the remote secondary volume includes swapping the replica base volume for the base volume.

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